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Rojas Labanda, Susana; Stolpe, Mathias

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Author : Susana Rojas Labanda and Mathias Stolpe

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Mathematical programming methods for large-scale topology optimization problems.

Structural topology optimization problems are today solved using sequential convex approximation methods such as the Method of Moving Asymptotes (MMA). This method was especially designed for use within optimal design and is by now extensively used both in commercial optimal design software and in academic research codes. However, this rather old first order method show poor convergence rates and may require many function evaluations for large-scale problems.

One of the goals of this project is to perform extensive numerical tests and compare the commonly used first-order special purpose optimization algorithms in the field of structural topology optimization, with existing state-of-the-art general purpose optimization methods. The second part of the project will consist in developing, analyzing, implementing and benchmarking efficient second order optimization methods which can utilize the particular mathematical structure of large-scale-structural topology optimization problems. In particular, we will analyze and implement tailored versions of a sequential linearly constrained Lagrangian method and a primal-dual interior point method. In general, these methods are both robust and show excellent local convergence properties in practice.

The theoretical analyses will focus on establishing local and global convergence while the implementation of the methods will focus on efficiency in the linear algebra related to these methods when applied to the same classes of topology optimization problems. We expect to significantly reduce the number of iterations compared to the existing and popular first order methods. Furthermore, we expect the number of iterations to remain almost constant with increasing problem size.